MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

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WILLIAM LASSELL, Esq., President, in the Chair.

Henry Barnes, Esq., The Moorlands, Clapham,

was balloted for and duly elected a Fellow of the Society.

On a Photograph of Jupiter. By J. Browning, Esq.

On the evenings of the 24th and 25th of October, which will be remembered for the magnificent displays of the Aurora Borealis —the air being steadier than usual,—I made two careful drawings of the planet *Jupiter*. As these were made on successive evenings,—the first on October 24, at 11 P.M. and the second on the 25th at 10.45 P.M., the drawings represent nearly the whole surface of the planet. The equatorial belt is of a fuller ochreish or tawny colour than when I last observed it—during the previous apparition. A bright belt to the north of the equator is much the brightest portion of the planet's disk. The dark belts on the northern side were of a very dark brown, with less copper colour in them than I found during my previous observations. The portion of the disk to the south of the equator was peculiarly free from belts. This refers especially to the views obtained on the 24th. The hemisphere seen on the 25th had a light and a dark belt about midway between the south pole and the equa-

tor and tolerably prominent. The ochreish belt was mottled all over the surface with white cloudy markings or patches—a distinct line of them, though separated by darker markings between, evidently encircled the whole of the planet, a little way to the south of the true equator.

I began a series of very careful micrometric measurements of the relative measures of *Jupiter*, to endeavour to determine whether any change had taken place in the proportions of the polar and equatorial diameters; owing to the very unfavourable state of the weather, I have not been able to complete these measurements.

Since writing the above, Lord Lindsay has shown me two photographic negatives of *Jupiter*, taken in Mr. De La Rue's Observatory on the same evening, within a quarter of an hour of the time I made my first drawing. It is worthy of remark that the equatorial belt in these negatives is almost absolutely transparent, the light from this orange-coloured belt having failed entirely to act on the sensitive collodion surface. I have seen negatives of *Jupiter* taken during previous years in which this equatorial belt had exerted the most action on the surface, giving the belt as quite opaque. I have appended a rough diagram of this negative to my paper. The periodicity of the change in the colour of the equatorial belt would be best determined by taking photographs of the planet.

In the plate A is a copy of the first coloured drawing of the planet taken on October 24th at 11 P.M., and B is a copy of the photographic negative, as seen with a microscope, taken within a few minutes of the same time.

It seems to me probable that a careful examination of photographic negatives of *Mars* might throw some light on the disputed question of the colour of the darker portions of the planet. We have evidently not yet exhausted the applications of photography to the cause of astronomical research.

On Periodical Changes in the Physical Condition of Jupiter.
By A. C. Ranyard, Esq.

During the past year, the changes which have been going forward on the surface of *Jupiter* have excited the attention of many observers. Several drawings have been shown at meetings of the Society exhibiting strong marks of colour not usually seen, and other drawings evidently very carefully executed show bright egg-shaped patches lying along the central belt; one by Prof. Mayer of Lehigh University, U.S., shows a reddish elliptical marking among the southern belts,—the same marking was observed in England by Mr. Gledhill, at Mr. Crossley's Observatory.

A similar increase of colour and bright egg-shaped markings

Malby & Sons, lith.

JUPITER.

A. From a drawing by JOHN BROWNING.
B. From a Photograph.

were observed in the years 1858, 1859, and 1860: Mr. Huggins, Mr. Lassell, Mr. Airy, and Sir W. Keith Murray, all noticed and figured them, their drawings in many respects correspond with those made in the course of the last season. The oblique markings described by Mr. Airy in 1860 have also been again observed, though only in a modified form, during the last epoch by Mr. Webb, of Hardwick, whose drawings in all other respects greatly resemble those by Mr. Huggins made in 1858–9.

It will be noticed by those interested in the periodicity of Sun-spots, that these two periods of maximum change on *Jupiter's* surface agree with two periods of maximum development of spots on the Sun's surface.

It becomes, therefore, interesting to inquire whether similar changes on the planet have been noted and figured at other periods of maximum solar disturbance. I have searched the *Index to the Monthly Notices*, recently prepared by Mr. Williams, and can only find one account of white spots being seen upon *Jupiter* previously to the year 1858.

This notice of them was at the beginning of 1850, when they are described by Mr. Lassell as having been "most remarkable." Mr. Dawes was at the meeting when the paper was read, and said he had seen the same appearance. There was a period of maximum solar disturbance in the year 1848, and both the magnetic and solar disturbances continued to be very considerable up to the year 1850.

The *Monthly Notices* of the Society do not extend back as far as the period of maximum solar disturbance which occurred previously to this in 1836–37.

I have at present had no opportunity of making any extended examination of observations of *Jupiter* taken previously to the commencement of the *Monthly Notices*, but the few accounts of white spots which I have already collected all occur near to some some period of maximum development of Sun-spots.

A table of such maxima since the year 1615 is given by Dr. Wolf, of Zürich, in the twenty-fourth number of his *Astronomische Mittheilungen*. I may especially mention some observations of Sir W. Herschel of white spots and irregular bands in 1778, 1779, and 1780—as well as the fact that he noticed what he called a "similar appearance" in June 1790. Two very considerable magnetic maxima occurred, the one in 1779·5, and the other in 1788·5, the last was a long while in subsiding, in fact there is a second and subsidiary maximum registered for 1792. Schroeter also notices the remarkable changes which took place on the surface of the planet in the winter of 1786.

The next three magnetic and solar maxima are very inferior in point of magnitude to the maximum of 1788–9, and if such slight negative evidence be of any value, I may mention that at present I have found no notice of white spots during the period from 1795 to 1830.

In the *Mémoires de l'Académie* for 1692, there is a paper on

Jupiter by Cassini, in which he notices great changes and bright spots on *Jupiter* about that time.

Dr. Wolf gives a Sun-spot maximum for 1693 ± 2.

There is a most interesting remark of Cassini's in this paper, especially when it is taken in connexion with the proper motion of spots upon the Sun's surface. He observed that the bright markings upon *Jupiter* had a proper motion of their own, and that that motion was greater the nearer the spots were situated to *Jupiter's* equator. It would be interesting to inquire whether this has been again noticed by Mr. Airy and other observers who have since attempted to determine the time of *Jupiter's* rotation.

If a future more complete examination of the observations of *Jupiter* should confirm the suspicion that the Sun and *Jupiter* have the same period of maximum disturbance, it would appear to show that the alternations on *Jupiter* are dependent upon some cosmical change, and not on any effect of tides as suggested by Dr. Wolf in the case of the Sun.

Automatic Spectroscope for Dr. Huggins' Sun Observations.
By Howard Grubb, Esq., C.E.

The spectroscope as exhibited is in an unfinished state, having been sent to Dr. Huggins for arranging some small matters of convenience, such as the dividing of Sector, Reading microscope, &c.

It consists of a combination of 4 compound prisms and 2 semi-compound prisms, all made use of twice, the total power of the instrument therefore being equal to 10 compound prisms, each having a dispersion of about 9°, that is, a total dispersion of about 90°, probably the largest ever obtained. The observing and collimating telescopes are respectively 6 and 4½ inches focus, and 1 inch aperture, the section of pencil actually in use being 1 inch by : 0·6 inch. This is perfectly constant from end to end of spectrum, as the prisms are automatically worked.

The prisms are 2¼ inches high, being just twice the height required for the section of pencil: the lower half being made use of for the first course of rays, the upper for the backward course.

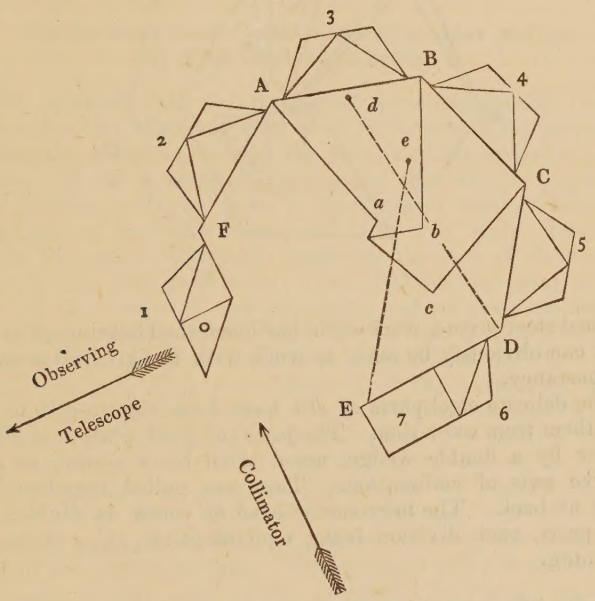
Referring to diagrams (the same letters of reference apply to both) the dotted lines represent those levers, &c., which are situated in a different plane, being at back of spectroscope. The right-angle prism of reflection (0) is applied only on the upper half of the first semi-compound prism (1), so that it does not interfere with the first course of the rays which utilize only the lower half of the prisms thus,—

The parallel rays from the collimator enter the lower half of the first semi-compound prism without refraction, this prism (1), therefore, is stationary. It then passes through four entire compound prisms, 2, 3, 4, 5, and one semi-compound, 6, from which by two internal total reflections in the prism of reflection, 7,

it is passed to upper half of prisms by which it returns through the four entire compounds and two semi-compounds, and is finally received emerging from the first fixed semi-prism by the right-angled prism of total reflection o, and so passed to the observing telescope which is placed at right angles to the collimator merely as a matter of preference. Any other position can be utilized if desired.

The prisms and automatic arrangement are contained in an air-tight box, and both observing and collimating telescopes are stationary, considerable advantages in such a powerful spectroscope, and allowing great compactness.

The several parts of the spectrum required to be examined are brought into the field by acting on the sector, which carries



the automatic arrangement, each line being exactly in minimum deviation when brought to centre of field.

The sector receding by a vernier to 10 seconds of arc divides the spectrum into about 20,000 parts.

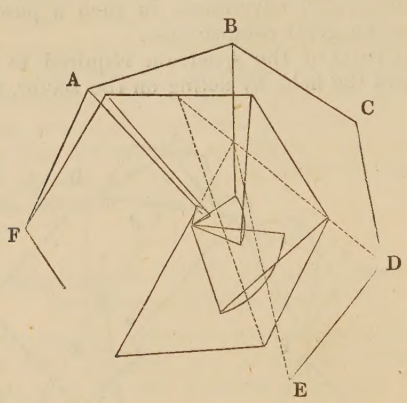
The mechanical arrangement of the automatic movement is that which we made a model of during Dr. Huggins' visit here last spring, and decided upon as giving the most constant and reliable results.

The motion is given to the chain of prisms entirely by a system of levers which will be easily understood from the diagrams.

The first three moveable joints of chain A B C are connected

by levers to the studs *a*, *b*, *c* fixed in a circular disc, which is rotated through 60° by toothed sector and pinion. The pins being fixed at their proper radii, draw the several prism tables through the required angle, the levers forming tangents in their mean position. The last two joints D and E were found geometrically to describe most accurately arcs of circles, they have therefore been attached to levers working on fixed centres at back of spectroscope, shown in the drawing by dotted lines.

The whole system of the automatic movement is composed of



hardened steel pivots, working in hardened steel bearings, a system which can obviously be made to work with the greatest accuracy and constancy.

The delicate steel parts of slit have been electro-gilt to preserve them from oxidation. The jaws (of gold plate) are drawn asunder by a double wedge, acted upon by a screw, so as to preserve axis of collimation. They are pulled together by a spring at back. The micrometer head of screw is divided into forty parts, each division being equivalent to $\frac{1}{40,000}$ of an inch of opening.

N.B.—The slots in table of spectroscope have nothing whatever to do with the guiding of chain of prisms. They are merely to allow of the junction of the two systems of levers working in different planes.

On a Standard or Uniform Measure of Time. By Lieut.-Col. Drayson, R.A., Professor of Surveying, R. M. Academy, Woolwich. (Abstract.)

The author considers that the Pole of the heavens, or axis of the Earth, describes a circle in the heavens during a long period of years, and that the only constant unit of time is, *cæteris pari-*

bus, the interval of time between two successive transits of the centre of the circle described by the Earth's axis—being, in fact, the mean of the intervals of the times of transit of any star within the circle, during an entire revolution of the axis. But as the obliquity is variable, the centre of the circle in question is not the pole of the ecliptic; and on examination of the evidence the author arrives at the conclusion that the centre is not (as he had somewhat hastily assumed) within a few minutes of arc from that pole, but that it may be stated to be 6° from the pole of the ecliptic, with, in the year 1860, a Right Ascension of about 268° 40′; and he finds that this result is consistent with the observed variation of the obliquity.

On the Graphical Construction of a Solar Eclipse.
By Prof. Cayley. (Abstract.)

The celestial sphere is projected stereographically, in such manner that the Moon's centre is at the centre of the projection, and that the meridian through the Moon's centre occupies a fixed position. If, for a moment, we suppose that we also project the Sun's relative orbit, we have at any instant during the eclipse the position of the Sun's centre, and with this centre describing a circle the radius of which represents the sum of the semidiameters of the Sun and Moon: then, if Q′ be any point on this circle, M the centre of the projection, and we draw the straight line, Q′ M, producing it to a point Z such that $Q'M = P' \sin ZM$ (where Q′ M, Z M denote the arcs represented by these lines respectively, and P′ is the difference of the parallaxes of the Moon and Sun, or say it is the quantity thus designated in the *N. A.* for 1836), then we have the position of a point Z on the Earth's surface, at which the Sun and Moon are, at the instant in question, seen in exterior contact; or by considering the series of points Q′ on the circle, we have the locus of the corresponding point Z, or, what is the same thing, the penumbral curve on the Earth's surface. The apparent orbit is not actually constructed on the scale of the projection, but on a greatly enlarged scale, in such manner that the parallactic depression due to a zenith distance 90° is represented by the radius of the bounding circle of the projection. And the actual process of constructing the projection of the penumbral curve consists merely in the graphical transformation of a circle by means of a properly graduated straight edge: viz. placing this with its centre-point on M, and so as to pass through any point Q on the circle (centre the position of the Sun's centre, and radius the sum of the semidiameters of the Sun and Moon, as actually represented on the enlarged scale) we at once mark off, by means of the graduation, the required point Z, and so obtain the projection of the penumbral curve at any instant during the eclipse. It will be observed that the Moon being always at the centre of the projection, and there-

fore any terrestrial meridian, say the meridian of Greenwich, a variable line on the projection, the projections of the penumbral curve for the different instants during the eclipse are constructed, not in their actual positions, but as affected with a variable displacement in longitude: we read off from the figure the latitudes and longitudes of as many points as may be necessary on any one of these curves, and so transfer the series of curves to a map on any projection which may be convenient.

It is further to be noticed that the stereographic projection required for the construction is one wherein the distance of the pole from the centre of the projection is the polar distance of the Moon's centre at the time of the eclipse, viz. that a different projection is required for each eclipse; the construction of such a projection would be by far the most laborious part of the whole, but it is fortunately unnecessary; viz. if we have a blank projection, in which the distance is $= 90^\circ$ (viz. the ordinary projection of an eastern or western hemisphere), but with the circles produced beyond the bounding circle, then we can, by simply drawing a new circle, cut out from it a projection in which the pole occupies the required position; see as to this the Note on a property of the stereographic projection, *Monthly Notices*, vol. xxx., p. 205. I constructed the blank projection, radius = 12 inches, and with the meridians and parallels at intervals of 5°; and completed the construction for the eclipse of Dec. 21–22, 1870, bringing out the times and places of the beginning and end of the eclipse with an error of about $1\frac{1}{2}$ minutes of time, and $1\frac{1}{2}^\circ$ of place; but I think that with a more complete blank projection, and more care in the construction, the limits of error might be greatly diminished; and that the construction, performed on the scale in question, would give results of as much accuracy as could be exhibited in a diagram such as the eclipse diagrams of the *Nautical Almanac*.

On the Proper Motions of 36 (A) *Ophiuchi and* 30 *Scorpii.*

By W. T. Lynn, B.A.

Perhaps the most remarkable instance of stellar Proper Motion which has been detected is that afforded by two stars on the boundaries of the constellations *Ophiuchus* and *Scorpio*. One of these, 36 (A) *Ophiuchi*, is a double star, and a known binary, the two components being of about the 5th and 6th magnitudes respectively. The other, 30 *Scorpii*, is a single star of the 7th magnitude. The distance in a great circle between A *Ophiuchi* and 30 *Scorpii* is about $12'\ 21''$, and the remarkable point is that both appear to be animated by a large proper motion of the same amount ($= 1''{\cdot}27$ in a great circle) and in the same direction. This has been long ago determined, but I have thought it might be useful to calculate the value as deducible from the observations made in recent years at the Greenwich Observatory. The stars

attain a meridian altitude at Greenwich of only about 12°, which renders the observations of N.P.D. somewhat uncertain; but, as their number is considerable, the result is entitled to be considered pretty accurate.

The following is a table of the results of the observations, as given in the successive great Catalogues,* with the number of observations contained in each:—

Authority.	Epoch.	A^1 Ophiuchi. R.A. h m s	No. of Obs.	A^2 Ophiuchi. R.A. h m s	No. of Obs.	30 Scorpii. R.A. h m s	No. of Obs.
12-year	1840	...		17 5 31·05	2	17 6 23·37	5
	1845	17 5 49·24	5	17 5 49·44	2	...	
6-year	1850	17 6 7·51	2	...		...	
7-year for	1860	17 6 44·47	12	17 6 44·66	9	17 7 37·18	8
7-year for	1864	17 6 59·27	3	17 6 59·33	1	17 7 51·80	2

		N.P.D.		N.P.D.		N.P.D.	
12-year	1840	116° 21′ 38″·87	7	116° 21′ 34″·95	11	116° 18′ 30″·26	10
	1845	116 22 4·83	1	116 22 0·64	1	...	
6-year	1850	116 22 36·76	3	...		...	
7-year for	1860	116 23 35·06	12	116 23 31·26	9	116 20 25·21	8
7-year for	1864	116 23 59·08	3	116 23 55·01	1	116 20 47·77	2

From these we obtain the following mean annual variation for each star:—

	In R.A. s	In N.P.D. ″
A^1 Ophiuchi	+3·689	+5·82
A^2 Ophiuchi	+3·675	+5·67
30 Scorpii	+3·675	+5·71

And, as the annual precession (for 1860) of 36 *Ophiuchi* amounts to $+3^s·718$ in R.A. and $+4''·62$ in N.P.D., and that of 30 *Scorpii* to $+3^s·717$ in R.A. and $+4''·54$ in N.P.D., it follows that the annual proper motion of each star deducible from the Greenwich observations will be:—

	In R.A. s	In N.P.D. ″
A^1 Ophiuchi	−0·029	+1·20
A^2 Ophiuchi	−0·043	+1·05
30 Scorpii	−0·042	+1·17

Greenwich, 1870, *December 3rd.*

* For the N.P.D.'s of the 12-year and 6-year Catalogues, the corrected values at the end of the 7-year Catalogue for 1860 are given.

On the Proper Motion of Oeltzen's Argelander 17415–6.

By W. T. Lynn, B.A.

This small star, which is of the ninth magnitude, was observed twice in the zone-observations of Argelander, and the two observations are numbered 17415 and 17416 in the Northern Catalogue formed by Oeltzen from those zones. Argelander had found that the star had a large Proper Motion, amounting to about $1''{\cdot}2$ of a great circle. Subsequently Krüger made a determination of its annual parallax with the Bonn heliometer, and found it to be $0''{\cdot}247$, with a probable error of $\pm 0''{\cdot}021$ (*Monthly Notices* for 1863, March 13, vol. xxiii. p. 173).

The star was entered for observation in the Greenwich Working Catalogue for 1864 and subsequent years. Unfortunately the N.P.D. was given erroneously, the declination in Oeltzen's Catalogue being inadvertently copied as N.P.D., and this mistake was repeated from year to year, being only detected quite recently. The star therefore numbered 1974 in the Greenwich Seven Year Catalogue for 1864 is not Oeltz. Arg. 17415, as it is there called, but a star whose declination is nearly the complement of that of the star in question.

On August 12, however, of the present year, the star was observed with the Greenwich transit-circle, and the mean place deduced from that observation is, for 1870, Jan. 1,—

R.A.	17^h	37^m	$10^s{\cdot}91$
N.P.D.	$21°$	$32'$	$32''{\cdot}30.$

Oeltzen's place for 1842 is,—

R.A.	17^h	37^m	$21^s{\cdot}32$
N.P.D.	$21°$	$31'$	$2''{\cdot}40.$

The precession for 1870 is in R.A. $-0^s{\cdot}298$, secular variation $+0^s{\cdot}0136$; in N.P.D. $+1''{\cdot}993$, secular variation $+0''{\cdot}0424$. So that Oeltzen's place, geometrically reduced to 1870, would be

R.A.	17^h	37^m	$12^s{\cdot}92$
N.P.D.	$21°$	$31'$	$58''{\cdot}04.$

From this we find the proper motion of the star to be

In R.A.	$-0^s{\cdot}07$
In N.P.D.	$+1''{\cdot}22.$

Applying the fractional part of this to the place deduced above from the Greenwich observation for 1870, August 12, we reduce the mean place for 1870, Jan. 1, to:—

R.A.	17^h	37^m	$10^s{\cdot}95$
N.P.D.	$21°$	$32'$	$31''{\cdot}55$

And it thus appears that the accurate annual proper motion, as far as it can be determined from this observation, is:—

In R.A.	$-0^{s}\cdot07$
In N.P.D.	$+1''\cdot20$.

I am permitted by the Astronomer Royal to communicate the observation, from which this result is deduced, to the Society.

Greenwich,
1870, *Nov.* 15.

Observations of Coggia's Comet (II. 1870). By J. Joynson, Esq.

1870.	Waterloo Sidereal Time. h m s	R.A. h m s	Decl. ° ′ ″ N.
Oct. 1	22 4 10	0 11 34	27 14 50
	22 40 11	0 11 14	27 14 55
	22 57 12	0 11 12	27 15 0
	23 29 54	0 11 7	27 15 10
	23 57 50	0 11 3	
	0 7 45	0 10 57	27 16 0
	0 25 40	0 10 54	27 16 10
2	21 39 7	0 4 22	27 42 5
	22 0 4	0 4 18	27 42 5
	22 29 56	0 4 9	27 42 10
	22 45 51	0 4 4	27 42 10
	22 59 46	0 4 0	27 42 15
	23 26 0 on an 8-mag. star.		
	23 30 0 just past.		
	23 45 36	0 3 50	27 42 15
	23 54 33	0 3 47	27 42 20
3	21 43 34	23 57 34	28 2 55
	22 24 22	23 57 22	28 3 10
	22 40 18	23 57 18	28 3 20
	22 57 12	23 57 12	28 3 25
	23 30 6	23 57 6	28 3 30
	23 45 2	23 57 2	28 3 30
4	22 22 12	23 50 12	28 22 15
	22 31 10	23 50 8	28 22 20
	22 50 8	23 50 6	28 22 20
	23 20 57	23 49 57	28 22 30
	23 49 50	23 49 50	28 22 40

Oct. 1 nucleus tolerably bright
2 ,, fainter.
3 ,, very faint. Moonlight
4 ,, barely visible. Moonlight.

On the 2nd, at $10^h\ 52^m\ 20^s$ G.M.T., the comet was on what I judged to be an 8-mag. star. The nucleus of the comet passed, I think, over the star, but it may perhaps have been a little north of it. When I thought the star and the nucleus were nearest I could not distinguish the comet at all, as the light of the star, small as it was, overpowered it; and the nucleus was some little distance, about its own apparent diameter, from the star before I could see it again.

The weather on the 5th October was very thick, and continued so for several days, thus preventing further observations.

Lat. 53° 28′ 24″ N.; Long. 0° 12′ 7″ W.

Waterloo, near Liverpool,
6th Dec. 1870.

Memoir by Hansen on the Transit of Venus.

The recently published Part V. of the ninth volume of the *Abh. der K. Sachs. Gesellschaft*, contains, pp. 457–552, an elaborate memoir by Dr. Hansen, "Bestimmung der Sonnenparallaxe durch Venusvorübergänge vor der Sonnenscheibe, mit besonderer Berücksichtigung des im Jahre 1874 eintreffenden Vorüberganges." Taking the mean distance of the Sun from the Earth to be a given number of units (for convenience it is put = 640), the unknown quantity upon which the solar parallax depends is the equatorial radius of the Earth, represented by ϱ_0; and comparing, at a given instant of time during the transit, the angular distance of the centres of the Sun and *Venus* as seen from the centre of the Earth with the angular distance as observed at a given position on the Earth's surface, we have for the determination of ϱ_0 a quadratic equation

$$m^2 \varrho_0^2 l^2 \cos^2 \mathrm{H} - 2 m \varrho_0 l \,\mathrm{S} \cos \mathrm{H} \cos (\mathrm{W}' - \Omega) + \mathrm{S}^2 - u^2 = 0, \qquad (\S\ 15)$$

which is the fundamental equation. The accuracy of the determination depends chiefly on the values of the two quantities, cos H and cos H cos θ_0, where H is the Sun's altitude, and θ_0 is the position-angle of *Venus* (or $\angle$ Z S V, if Z is the zenith of the place of observation, S, V the centres of the Sun and *Venus* respectively); viz. each of these quantities should be as large as possible: cos H = 1 would, however, imply H = 0°, and on account of refraction, &c., the observation would be impracticable; it is, therefore, assumed that at the time of observation, the Sun must have a certain altitude, say cos H = k, where k is as large as may be; the other condition then leads to the consideration of the curves cos H cos $\theta_0 = k$, viz., k having any given value, the locus of the points on the Earth's surface for which this condition is satisfied is said to be an "isothenic curve;" and then on a given isothenic curve the most advantageous position is that for which cos $\theta_0 = \pm 1$; the locus of the points for which the last-mentioned condition is satisfied is said to be a "principal-altitude

curve" (Haupthöhen-curve). It is shown that the isothenic curves are small circles on the sphere. The memoir contains various numerical results in regard to the transit of 1874, and also two maps, a northern and a southern hemisphere, on the stereographic projection, exhibiting the isothenic and chief-altitude curves for the phases of ingress, egress, and nearest approach respectively, and also the eastern and western limit-curves of the transit. A conclusion arrived at is, that "By distance-measurements, at the instant of greatest phase, in favourable localities, the parallax can be obtained almost independent of errors in the longitude of the place of observation, or in the time: for such observations there is not any favourable position in the southern hemisphere—but in the northern hemisphere a wide field—in Siberia from about Tomsk to the Sea of Ochotsk, the region of the Amoor, the coasts of Mantchuria, the Japanese and part of the Kurile Islands, the peninsula of Corea." It is here, Dr. Hansen thinks, that the best results are to be obtained from the approaching transit.

There are three Appendices, the last of which contains formulæ for the application of photographic observations to the determination of the parallax. The formulæ require (besides the distance of the centres of the Sun and *Venus*) the determination of the position-angles of *Venus* at the two stations respectively. It is suggested that there should be at the focus of the instrument a wire in the plane of the declination circle, to be represented in the photograph, and thus to serve as a ground-line for the measurement of the position-angle, but the author is unable to judge as to the degree of accuracy with which the position-angle can be in this way determined.

As regards the geometrical theory it may be remarked that if a right cone intersects a sphere, the plane through the axis of the cone and the centre of the sphere (say the axial plane) meets the curve of intersection of the cone and sphere in two or four points which may be called vertices; moreover, we may, in the axial plane at right-angles to the line joining the centre of the sphere with the vertex of the cone, draw a diameter, the extremities of which are, say, the two points, K, K′. Now, considering the cone as variable (viz., in the astronomical problem the sphere is the Earth regarded as fixed in space and about its axis), the principal-altitude-curves are the locus of the vertices; and if with the variable centre K or K′ we describe on the sphere a circle of a constant given radius, the locus of the intersections of this circle with the intersection-curve of the cone and sphere is (or may be taken to be) one of the isothenic curves.

New Comet (IV. 1870).

Extracts of Letter from Dr. Winnecke to Mr. Hind.

Carlsruhe, 1870, *Nov.* 24.

Last night a small telescopic comet was discovered by me near γ *Virginis*; from five comparisons with Schjellerup 4610 its position is :—

M.T. Carlsruhe.

Nov. 23, $17^h\ 52^m\ 15^s$ R.A. $= 12^h\ 42^m\ 33^s{\cdot}36$ $\delta = -3^\circ\ 29'\ 19''{\cdot}9$.

The daily motion in R.A. is about $+\ 15^m$; in Decl. not sensible. The Comet is bright, round, and its diameter is about $2\frac{1}{2}'$.

Carlsruhe, 1870, *Nov.* 26.

From Carlsruhe, Nov. 23, 24, 25, I deduced the following orbit of the new comet :—

T = 1870, Dec. 19·836, Berlin.

$$\left.\begin{aligned} \pi &= 9^\circ\ 25'{\cdot}8 \\ \Omega &= 94\ 14{\cdot}9 \end{aligned}\right\} \text{ App. Eq.}$$

$$i = 30\ 14{\cdot}7$$

$$\log q = 9{\cdot}63244$$

Retrograde.

For middle observation $\Delta\lambda = +\ 0''{\cdot}7$ $\Delta\beta = -\ 0''{\cdot}1$.

New Comet.

Ephemeris from Dr. Winnecke's Elements by Mr. Hind.

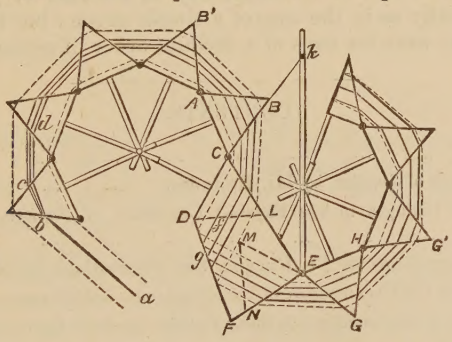
1870.	At Greenwich, midnight. Comet's R.A.	Comet's N.P.D.	Log. Δ	$\frac{1}{r^2\Delta^2}$
	h m	° ′		
Dec. 1	15 32·8	96 8	9·6014	15·8
2	15 59·3	96 22		
3	16 24·3	96 34	9·6197	16·2
4	16 47·9	96 42		
5	17 9·5	96 49	9·6575	15·2
6	17 29·0	96 55		
7	17 46·4	97 0	9·7065	13·6
8	18 1·7	97 6		
9	18 15·0	97 12	9·7600	11·8
10	18 26·6	97 19		
11	18 36·6	97 28	9·8133	10·2
12	18 45·3	97 38		
13	18 52·7	97 50	9·8644	8·8
14	18 59·1	98 3		
15	19 4·5	98 18	9·9118	7·6

On a Contrivance for extending the principle of Mr. Browning's Automatic Spectroscope to a second battery of Prisms. By R. A. Proctor, B.A.

The principle of automatic adjustment devised by Mr. Browning has increased value the larger the number of prisms to which it is applied. So that if we require to use a second battery through which the light shall be carried after one reflection (and therefore with a deviation in a contrary direction to that taking place in the first battery), it becomes highly necessary that some contrivance should be adopted to secure automatic adjustment. This is yet more necessary if the light is to be sent back through both batteries.

The following plan, adopted after I had devised several others and rejected them on account of probable slight defects in their action, seems likely to be effective.

Suppose A B C to be the last prism of the first battery, G E H the first prism of the second battery, and C D F E an intermediate quadrilateral prism, so figured that the face, C E, belongs to the first battery—bearing the same relation to C B that A B bears to A B′—and that the face, E F, bears the same relation to E G that H G bears to H G′, while D F is inclined at an angle of forty-five degrees to the axis, *f g*, of the pencil of light, *a b c d*, passing parallel to C D. Then it is obvious that we only require that the imaginary prisms, C D L (shaped as A B C, &c.) and E N M, (shaped as G E H, &c.) should be kept in true and similar automatic adjustment with respect to the other prisms of the two



batteries. This is secured by having slots so attached to the prism, C F, as to be rectangular bisectors of C D and M E (C D L, M N E, being imaginary component prisms of the first and second batteries), while a slotted bar, E *k*, is caused to be always at right angles to O C by pivoting round E and slotting at *k*, where C *k* is a rod equal in length to the line C E.

The angles of C F are easily determined. C of course is equal to a base-angle of any prism of either battery. D is an angle of 135 degrees, E is a right-angle.

I forbear from giving a more detailed description at present, because Mr. Browning is constructing a spectroscope on this plan, and an opportunity will be afforded when he brings the instru-

ment before the Society, of discussing more at length the principles on which its action depends. In this instrument a dispersive power equal to that given by 19 or 21 equiangular prisms will be conveniently secured.

But it is easily seen that neither the automatic movement nor the optical conditions require the prism E G H to be attached directly to the angle E of the quadrilateral prism. By a separation here, it becomes possible to extend the second battery, so as to secure a dispersive power equal to that given by 23 or 25 prisms.

It may be well to note that the only points which are novel in the above arrangement (so far as I know) is the plan by which the light is carried from one battery into another without any loss of light (the refractions being both *effective*, and the reflection total); and the extension of the automatic method to include both batteries. The return of the rays after reflection is, of course, no new device, having been suggested many years since, and applied successfully by Mr. Browning four or five years ago. In this plan, as in the modification I have suggested on Mr. Browning's plan, the optical condition which minimum deviation is intended to fulfil is secured with mathematical exactitude (setting aside the point referred to in my paper on the subject in vol. xxx. of the *Notices*, No. 9). Mr. Grubb has devised a plan by which minimum deviation through compound prisms is automatically secured; but minimum deviation, *per se*, and the optical condition which minimum deviation through a single triangular prism fulfils, are different matters. We can secure the former in rays of all orders of refrangibility, in the case of a compound prism as readily as in the case of a simple prism; but the latter we cannot secure save for rays of a definite order of refrangibility.

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